rection, yVcom **123**. In addition, pixel **101** includes a connection **127** that connects portion **121***a* to portion **123***a*. Thus, connection **127** connects xVcom **121** and yVcom **123**.

[0084] Pixel **104** is similar to pixel **101**, except that a portion **125***a* of a yVcom **125** has a break (open) **131**, and a portion **121***b* of xVcom **121** has a break **133**.

[0085] As can be seen in FIG. **1**, the lower electrodes of storage capacitors of pixels **101**, **102**, and **103** are connected together by xVcom **121**. This is a conventional type of connection in many LCD panels and, when used in conjunction with conventional gate lines, data lines, and transistors, allows pixels to be addressed. The addition of vertical common voltage lines along with connections to the horizontal common voltage lines allows grouping of pixels in both the x-direction and y-direction, as described in further detail below. For example, yVcom **123** and connection **127** to xVcom **121** can allow the storage capacitors of pixels **101**, **102**, and **103** to be connected to storage capacitors of pixels that are above and below pixels **101**, **102**, **103** (the pixels above and below are not shown). For example, the pixels immediately above pixels **101**, **102**, and **103** can have the same configurations as pixels **101**, **102**, and **103**, respectively. In this case, the storage capacitors of the pixels immediately above pixels **101**, **102**, and **103** would be connected to the storage capacitors of pixels **101**, **102**, and **103**.

[0086] In general, an LCD panel could be configured such that the storage capacitors of all pixels in the panel are connected together, for example, through at least one vertical common voltage line with connections to a plurality of horizontal common voltage lines. Another LCD panel could be configured such that different groups of pixels are connected together to form a plurality of separate regions of connected-together storage capacitors.

[0087] One way to create separate regions is by forming breaks (opens) in the horizontal and/or vertical common lines. For example, yVcom **125** of panel **100** has a break **131**, which can allow pixels above the break to be isolated from pixels below the break. Likewise, xVcom **121** has a break **133**, which can allow pixels to the right of the break to be isolated from pixels to the left of the break.

[0088] FIGS. **2**A and **2**B illustrate example regions formed by breaks in vertical and horizontal common voltage lines according to embodiments of the invention. FIG. **2**A shows a TFT glass region layout. FIG. **2**A shows a region **201**, a region **205**, and a region **207**. Each region **201**, **205**, and **207** is formed by linking storage capacitors of a plurality of pixels (not shown in detail) through common voltage lines in the vertical direction (y-direction) and in the horizontal direction (x-direction). For example, the enlarged area of FIG. **2**A shows pixel blocks **203***a-e*. A pixel block includes one or more pixels, in which at least one of the pixels includes a vertical common line, yVcom. FIG. **1**, for example, illustrates a pixel block that includes pixels **101-103**, in which pixel **101** includes yVcom **123**. As seen in FIG. **2**A, pixel block **203***a* is connected in the horizontal direction to pixel block **203***b* through a horizontal common line, xVcom **206**. Likewise, pixel block **203***a* is connected in the vertical direction to pixel block **203***c* through a vertical common line, yVcom **204**. A break in xVcom **206** prevents block **203***a* from being connected to block **203***d*, and a break in yVcom **204** prevents block **203***a* from being connected to block **203***e*. Regions **201** and **207** form a capacitive element that can provide touch sensing information when connected to suitable touch circuitry, such as touch circuitry **213** of touch ASIC **215**. The connection is established by connecting the regions to switch circuitry **217**, which is described in more detail below. (Note, for IPS-type displays there are no conductive dots required. In this case, the XVCOM and YVCOM regions may simply extended with metal traces that go to the Touch ASIC which is bonded to the glass in a similar way as the LCD driver chip (through anisotropic conductive adhesive). However, for non-IPS-type displays, the conductive dots may be needed to bring the VCOM regions on the color filter plate into contact with the corresponding regions on the TFT plate.) Likewise, region **201** and region **205** form a capacitive element that can provide touch information when connected to touch circuitry **213**. Thus, region **201** serves as a common electrode to regions **205** and **207**, which are called, for example, sense electrodes. The foregoing describes mutual capacitance mode of touch sensing. It is also possible to use each region independently to measure self-capacitance.

[0089] As described above, the regions connected-together storage capacitors of pixels can be formed using vias between common voltage lines, such as xVcom and yVcom in FIG. **1**, and using selective breaks in the common voltage lines. Thus, FIG. **2**A illustrates one way in which vias or other connections and selective breaks can be used to create capacitive regions that can span many pixels. Of course, in light of the present disclosure, one skilled in the art would readily understand that regions of other shapes and configurations can be created.

[0090] FIG. **2**B shows a CF glass patterned ITO region layout, which may or may not be needed, depending on the type of LCD technology used by the pixel. For example, such CF ITO regions would not be needed in the case that the LCD pixel utilizes in-plane-switching (IPS). However, FIG. **2**B is directed to non-IPS LCD displays in which a voltage is applied to liquid crystal between an upper and lower electrode. FIG. **2**B shows upper regions **221**, **223**, and **225**, which correspond to lower (in non-IPS displays) regions **201**, **205**, and **207**, respectively, of FIG. **2**A. FIG. **2**B shows conductive dots **250** contacting regions **251**, **255**, and **257**. Conductive dots **250** connect the corresponding upper and lower regions such that when to the upper electrodes of pixels in an upper region are driven, the corresponding lower electrodes of pixels in the lower region are also driven. As a result, the relative voltage between the upper and lower electrodes remains constant, even while the pixels are being driven by, for example, a modulated signal. Thus the voltage applied to the liquid crystal can remain constant during a touch phase, for example. In particular, the constant relative voltage can be the pixel voltage for operation of the LCD pixel. Therefore, the pixels can continue to operate (i.e., display an image) while touch input is being detected.

[0091] A touch sensing operation according to embodiments of the invention will be described with reference to FIGS. **3-5**B. For the sake of clarity, the operation is described in terms of a single drive pixel and a single sense pixel. However, it is understood that the drive pixel is connected to other drive pixels in a drive region and the sense pixel is connected to other sense pixels in the sense region, as described above. Thus, in actual operation, the entire drive region is driven, and the entire sense region can contribute to the sensing of touch.

[0092] FIG. **3** shows partial circuit diagrams of a pixel **301** of a drive region and a pixel **303** of an example sense region. Pixels **301** and **303** include TFTs **307** and **309**, gate lines **311** and **312**, data lines **313** and **314**, xVcom lines **315** and **316**,